In reply

Anaerobic storage of red blood cells: the need for caution regarding donor red cells with sickle cell trait

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Dear Sir,

We concur with observations made by Dr. Ahmed in his letter "Anaerobic storage of red blood cells: the need for caution regarding donor red cells with sickle cell trait"[1] about the potential unsuitability of anaerobic conditions for the storage of sickle cell trait (SCT) blood. Blood containing HbAS is well known to clog up leucoreduction Þlters and to enable unacceptable levels of leucocytes to escape during the Þltering process[2]. At sufÞciently low pO_2, pH and high mean corpuscular haemoglobin concentration, HbAS in red blood cells (RBC) of SCT carriers polymerises. Although SCT is considered benign, symptoms and pathology suggesting occurrences of serious sickling events have been reported in numerous cases involving healthy SCT carriers placed under extremely demanding anoxic conditions[3]. Polymerisation of HbAS is well underway at a pO_2 below 35 Torr for RBC with an HbS content of 40% or less, reducing RBC deformability and resulting in the well-described obstruction of leucoreduction Þlters[2]. In order to obtain signiÞcant anti-oxidative and metabolic beneÞts, we target anaerobic red blood cells to have less than 3% haemoglobin oxygen saturation ($\%SO_2$) before placing units in storage, and then maintain this low SO_2 state throughout the storage period[4]. The pO_2 required to achieve an SO_2 below 3% is less than 5 Torr at 4 °C, and under such a low pO_2, HbAS would polymerise. Even if it was permissible, inclusion of anti-sickling agents would be insufÞcient to prevent HbAS polymerisation, and storing RBC under a highly sickled state is known to be unacceptable because of prolonged mechanical stress to the cells and resulting haemolysis. If successful collection and storage of SCT blood is speciÞcally desired, a test to exclude units with HbAS will be necessary to avoid subjecting these collected RBC to the anaerobic treatment. Further investigation will be required to determine the feasibility of storing SCT blood with a low HbS content.

The AABB guidelines for transfusing erythrocytes containing sickle haemoglobin recommend avoiding transfusion of HbAS blood to foetuses and neonates, as well as to patients with sickle cell disease, but there is no deÞnitive clinical evidence indicating a necessity to exclude RBC units containing HbAS for general transfusion[5]. Despite the fact that RBC containing HbAS are diluted in the recipient upon transfusion, under anoxic conditions that may exist in the recipient's capillaries, these RBC may become rigid due to gelation of HbAS resulting in compromised oxygen delivery. Furthermore, RBC sickling in anoxic capillaries may result in capillary plugging and further harm the tissues. The safety of HbAS blood in the context of the general blood supply is an issue that lies outside the scope of Dr. Ahmed's letter. For the reasons stated above however, we believe it is one that merits further careful scrutiny.

In routine transfusion practice, we do not expect any harm to come from transfusing anaerobic blood to recipients, since infused RBC will be fully oxygenated at their Þrst pass through the pulmonary capillaries. The effects of transfusing anaerobic blood to sickle cell disease patients will also need careful investigation.

References

1) Ahmed SG. Anaerobic storage of red blood cells: the need for caution regarding donor red cells with sickle cell trait. Blood Transfus DOI 10.2450/2011.0110-10.
2) Beard MJ, Cardigan R, Seghatchian J, et al. Variables determining blockage of WBC-depleting Þlters by Hb sickle cell trait donations. Transfusion 2004; 44: 422-30.
3) Mitchell BL. Sickle cell trait and sudden death-bringing it home. J Natl Med Assoc 2007; 99: 300-5.
4) Yoshida T, Shevkoplyas SS. Anaerobic storage of red blood cells. Blood Transfusion 2010; 8: 220-36.
5) Mullersman J, Carnahan, GE. Guidelines for Transfusion of Erythrocytes Containing Sickle Hemoglobin. Bethesda MD: AABB ed., 2004.

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